Turbulent direct-contact heat transfer between two immiscible fluids

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Résumé en anglais	Heat transfer between two immiscible liquid phases in turbulent flow is of great interest in improving the residence time, compactness, and energy cost of cooling and heating processes. The high-efficiency vortex (HEV) device used here as a direct-contact heat exchanger (DCHE) is a generic multifunctional exchanger/reactor in which wall tabs generate longitudinal vortices responsible for convective radial transfer that enhance macro-mixing, phase dispersion and fast temperature homogenization in the flow. The experiments reported here concern a continuous flow of water in which an immiscible mineral oil is injected. The inlet water temperature ranges from 11 to 13 °C, and the inlet oil temperature from 40 to 48 °C; the flow Reynolds number varies between 7500 and 15 000. An algebraic one-dimensional thermal model accounting for the axial evolution of the phase temperatures coupled with drop breakup is developed and validated by the experimental thermal results in the DCHE. This model requires knowledge of the turbulent field in single-phase conditions; it can be adapted to other flow geometries and can be used as a sizing tool for engineering design. Despite the phase separation at the outlet, the DCHE is more efficient than a double-jacketed heat exchanger in terms of global Nusselt number. In addition, the HEV heat exchanger is energetically less costly than the other DCHE for the same heat-transfer capacity.
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